Chemical & Engineering NEWS
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Chemical & Engineering NEWS

Cover: Sulfur being loaded into hopper cars. Photo courtesy of Texasgulf

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Mineral inorganics: steady and profitable

Sulfur and potash are doing best because of strong fertilizer market: lime is limited by slack steel market; phosphorus just survives

Many of the usual causes of excitement in commercial chemicals are denied the largest-volume U.S. inorganics based on minerals. Big product growth, high investment, and breakaway technology are not reasons to talk about lime, sulfur, potash, and phosphorus in comparison with petrochemicals or other groups.

These long-established products have a scale of their own which dictates a different kind of rating. From a huge production base, they sold reasonably well in 1979 on their own terms, a trend that has continued so far this year. They all have high plant capacity use.

In profitability, sulfur and potash are well off in tight markets because of a strong year in their dominant market, fertilizer. Lime is considered healthy, although its biggest market, steel, is soft because of the decline in U.S. automobile production. Lime's pollution-control markets are growing well.

The merchant stance of phosphorus is somewhat academic, since producers convert most of it to derivatives. Some of these have high investment rates, and the largest category, detergent phosphates, is making a comeback after a decade of decline. Overall, the phosphorus business is still static with economics under pressure from its energy-intensive cost structure.

Aside from phosphorus, the smallest-volume chemical of the four inorganics, the others are all big merchant commodities. Hence, they provide producers with a large revenue base and substantial profits for expansion or investment elsewhere. Combined production value of the four products will cross the $3 billion mark in another year or so. The $2.88 billion estimated value in 1980 is up 23% from $2.35 billion in 1979.

Over the past decade, the combined value of these inorganics has risen a little ahead of the general inflation rate. From $919 million in 1969, this value increased an average of 10% per year to $2.35 billion in 1979. The increase was largely related to increasing energy costs for sulfur, lime, and phosphorus, which require high temperatures in their production.

In tonnage produced, three of the four chemicals have little or no growth in sight this year, much as in the past decade. The fourth, sulfur, will have one of its best years with 7% production growth from all sources. Sulfur has had the best growth of the four in the past decade but has still averaged only 2% growth per year. Lime had zero average annual growth in the 1970's, potash output declined 2% annually, and phosphorus production fell 3% a year.

Even so, the size of these inorganics' production is imposing. At a combined 37 million tons (74 billion lb) in 1980, up 1 million tons from 1979, their volume is larger than that of the combined leading oil-based petrochemicals in C&EN's Key Chemicals series (C&EN, Nov. 19, 1979, page 10).

Market value is another matter. The four inorganics' merchant revenue in 1979 was probably only a third of the $4.5 billion from the leading petrochemicals. Hence, the inorganics, except phosphorus, are relatively cheap and invite large-scale use.

Despite their low price among major chemicals and the relatively high effect of transportation cost, sulfur and potash have a large foreign trade, with the U.S. a net importer in both cases. Foreign trade is quite small for lime and phosphorus.

Although considerable frustration is evident in these chemicals' production record in the 1970's, many producers are pushing new markets for them for the 1980's. To date, these markets are too new and too small to affect total volume in these materials.

Lime's hopes are largely in pollution control. In the late 1970's, lime had large increases in use in stack-gas scrubbers, sewage treatment, acid neutralization, and sulfur removal.

Phosphorus now has more than 10% of its use in specialty compounds going into flame retardants, lubricating additives, and pesticides. Combined growth of these could be about 5% a year. In addition, phosphorus finally may be out of the tunnel in detergent phosphates, its largest use, after a decade under pressure because of water pollution concerns. New formulations will increase phosphorus use in detergent phosphates slightly in 1980.

Sulfur and potash, despite growth in smaller uses, will depend on fertilizer for their fortunes, which is fine with producers, at least for now. Fertilizer was booming in 1979 and is expected to continue strong through 1980. However, fertilizer's history of big ups and downs lagging the general business cycle indicates that sulfur and potash will have more cycles in their future, despite optimistic predictions on worldwide fertilizer needs in the 1980's.

For details on the immediate 12-month market outlook for these four chemicals, see the following pages.

Bruce Greek, Houston, and William Fallwell, New York

During 1970's, mineral-based inorganics grew little or declined in volume but doubled or tripled in value

	Production[a] (Billions of tons)			Production value ($ Millions)		
	1979	1969	Annual change, %	1979	1969	Annual change, %
Lime	20.4	20.2	0.1%	$850	$263	12%
Sulfur	11.7	9.5	2	800	360	8
Potash	2.3	2.8	−2	200	73	11
Phosphorus	0.46	0.62	−3	500	223	8

a Long tons for sulfur (1 long ton = 2240 lb). Sources: Commerce Department, Interior Department, industry and C&EN estimates

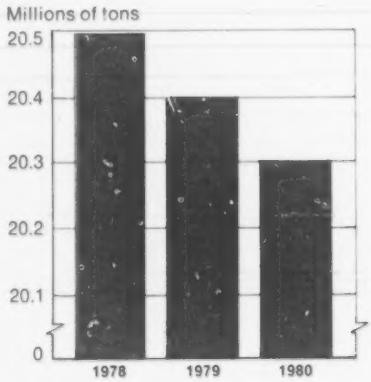
Key Chemicals

Lime

CaO

- ***Production easing***
- ***Capacity up a little***
- ***Prices rising***

PRODUCTION



Note: No capacity estimates are available.

HOW MADE

Calcining limestone (mainly $CaCO_3$) to make quicklime, CaO, by driving off carbon dioxide; quicklime then hydrated with water to make hydrated lime, $Ca(OH)_2$

MAJOR END USES

Metallurgy (mainly steel flux) 45%, chemical manufacture 10%, potable water treatment 10%, sewage and pollution control 5%

FOREIGN TRADE

Exports—about 50,000 tons in 1980, imports—rising to about 700,000 tons in 1980

PRICES

$35 to $50 per ton, depending on type

COMMERCIAL VALUE

$850 million for total production, 1979; $1 billion, 1980

U.S. lime producers face another sluggish year, similar to 1979. Production may decline slightly to 20.3 million tons from 20.4 million tons in 1979. Some new plants are being built, but a large part of this new capacity will replace obsolete capacity. Although exact capacity figures are hard to come by, capacity use probably is running 90% or better at present.

Prices for merchant lime and costs of captive lime will continue to rise as energy costs rise. Lime is energy-intensive because of the high temperatures used to calcine the ore.

Because nearly half of lime one way or another is used for metals and ore processing, lime's fortunes follow those of the metals industry, steel in particular. The steel industry, reflecting slow auto sales, has been having its own recession. Lime consumption as a result has fallen off and is now holding at a lower level than a year ago.

However, because steel also is tied to armament manufacture, some small improvement in steel demand could occur this year as government defense spending increases. Lime demand and production then could follow. If the reversal occurs soon enough and steel output rises enough during the second half of the year, lime production could pull off a small gain for 1980 instead of the forecast small decline.

Even if lime production during 1980 equals or exceeds 1979 production, possibly rising to 20.5 million tons, it still will be below the record production high of 21.6 million tons established in 1974.

A major part of lime production goes for captive uses, mainly in steelmaking. However, this share of production has been in a decline accelerated by the slump in steel production. Currently, captive lime production accounts for less than a one-fourth share of total production.

Formerly, a large part of captive lime production was used to manufacture soda ash synthetically. With the shift to natural soda ash, many of the old lime kilns were shut down, further reducing the fraction of captive lime production.

Producers may phase out old kilns faster than they would otherwise because of stack emission regulations. Currently, the Environmental Protection Agency wants emissions limited to 0.3 lb per ton of feed limestone. At this limit, producers would be required to achieve about 99.9% collection, a goal not possible for some kilns without prohibitively expensive modifications. Some lime producers say that a limit of 0.6 lb per ton of feed may be more practical for new or modernized kilns. Implementation of emission standards has been delayed, so the effect on lime production during 1980 probably will be negligible.

A turnaround in lime production may be coming from demand for lime in stack gas scrubbing to reduce sulfur dioxide emissions from power plants. This use of lime increased substantially during 1979. However, this method of removing sulfur dioxide has technical problems as well as relatively high costs. Some industry sources predict a leveling off in use of lime in scrubbers later on in the 1980's.

Use of lime scrubbers is only one part of the substantial use of lime in various kinds of pollution control. In 1980, these uses, including sewage treatment, acid neutralization, and sulfur removal, could require more than 1.6 million tons, up from just over 1.2 million tons in 1978. Sewage treatment will take about 700,000 tons of the total. Sulfur dioxide removal probably will take 600,000 tons in 1980, possibly more.

Pulp and paper manufacture requires about 1 million tons a year of lime. This consumption is all in the initial charge to the mill. After this first loading, large quantities of lime are recovered in the chemical recovery section of pulp mills and re-used. This lime is not included in production estimates.

Most other uses of lime, such as construction of roads and parking lots, glass, and chemicals, are small and are not growing much on balance. Some of these applications of lime have shown declines in consumption in recent years.

On balance, lime production and consumption in 1980 will remain in a holding pattern. Producers will continue to be buffeted by high energy costs and new pollution control regulations. They will continue to pass costs along but probably will show little profit improvement.

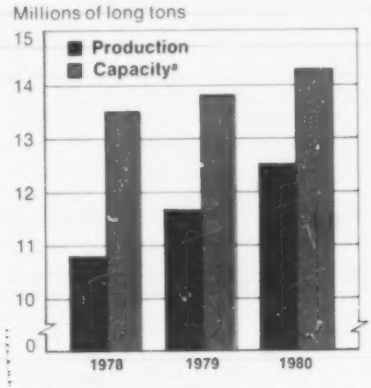
Key Chemicals

Sulfur

S

- ***Production rising***
- ***Demand strong***
- ***Prices rising***

PRODUCTION/CAPACITY



[a] First quarter; excludes standby capacity of about 5 million long tons at recovery plants and smelters

HOW MADE

Melted from underground ores (Frasch); recovered from sulfur compounds processed in refineries, natural gas processing plants, and smelters

MAJOR END USES

Fertilizer manufacture 60%, chemicals manufacture 20%

FOREIGN TRADE

Exports—2.1 million long tons in 1980, imports—2.5 million long tons in 1980

PRICES

$116 per long ton, contract f.o.b. Tampa, with spot prices up to $30 higher; much lower prices for by-product at smelters

COMMERCIAL VALUE

$800 million for total production, 1979; $1 billion, 1980

U.S. sulfur producers are struggling to meet demand this spring, and the product is considered in short supply. Remaining inventories are being drawn down. Production is expected to increase this year 7% to 12.5 million long tons from 11.7 million long tons in 1979, but this rate is below what the market could take. Prices will continue to increase even after two increases posted so far this year.

As of now, producers' struggle to meet demand doesn't look as if it will become easier in 1980. However, a more severe recession than now is expected could change the market from tight to adequate with possibly some inventory rebuilding.

Sulfur capacity will expand at about the same rate as production this year. During 1979, capacity grew 4% from 13.8 million long tons in first-quarter 1979 to 14.3 million long tons in first-quarter 1980.

A breakdown of 1980 sulfur production forecasts shows Frasch sulfur still the largest source at about 6.75 million long tons. About 4.3 million long tons will be recovered from various oil- and gas-processing operations. Another 1.25 million long tons equivalent will come from metal-smelting operations. And about 300,000 long tons from pyrites.

About 60% of the 1980 production growth will be from Frasch production, which will increase about 500,000 long tons. Recovered sulfur production will be up about 300,000 long tons. Both smelter and pyrite sources for sulfur or its equivalent as sulfuric acid will hold about level with 1979 production.

Frasch sulfur production increases will result from fewer production problems at some locations and minor debottlenecking. As always, a severe hurricane at or near Frasch sulfur production locations on the Gulf Coast could depress production gains.

Production increases of recovered sulfur are well below forecasts of recent years. The reason for slower growth comes from a slower-than-expected shift to use of more sour crudes (those having higher sulfur content) by petroleum refiners. Even though the cost of sweeter crude oil is higher, refiners have expanded capacity to handle sour crudes only slowly, since they expect declines in gasoline demand to continue. Replacement of cutoff Iranian crude oils, relatively more sour than Arabian, also will tend to hold down recovered sulfur production.

Sulfur-equivalent production from smelters might fall significantly if there is a strike by smelter workers this year. However, overall smelter sulfur production could be about the same as in 1979 if any strike is short.

Sulfur production from pyrites is so small in the total picture that even large changes would have a tiny effect. No such changes are expected this year.

Since sulfur demand is now running ahead of supply, some spot prices are as much as $30 per ton above the $116-per-ton standard f.o.b. contract price at Tampa, Fla. At some locations, no spot sulfur is available at all.

The sulfur squeeze has been going for a year since cessation of Iranian oil and by-product sulfur exports in early 1979. A worldwide scramble for sulfur quickly dried up elemental and by-product supplies, even in the U.S. The tight market continued after Iranian oil exports resumed because of the worldwide boom in phosphate fertilizer. For 1980, a further supply constriction could develop if the copper industry suffers a strike when major union contracts expire at the end of June.

The demand strain comes almost entirely from demand for derivative sulfuric acid in making phosphoric acid for fertilizer materials. The outlook for fertilizer is quite uncertain because of political developments, most notably the phosphates trade cutoff with the Soviet Union. However, even if a slackening of robust U.S. demand occurs, exports probably still will take up the slack in non-Soviet areas.

Although demand remains strong for phosphate fertilizer materials, the quality of unmined phosphate rock is declining. The result is that more sulfuric acid is needed to make the same quantity of phosphoric acid. This can only add to the strain on sulfur supply.

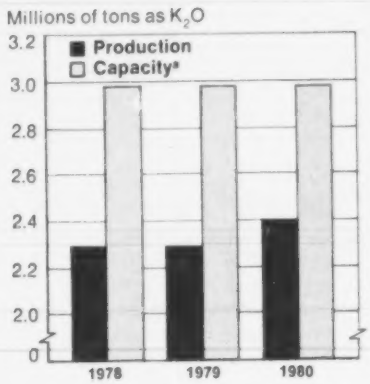
None of the many nonfertilizer uses of sulfuric acid and elemental sulfur will fall off enough during 1980 to compensate for the pressure from fertilizer manufacturers. As a result, sulfur producers' race with demand may continue throughout the year.

Potash

KCl, K_2SO_4, $K_2SO_4 \cdot 2MgSO_4$

- ***Output up slightly***
- ***Capacity flat***
- ***Prices firming***

PRODUCTION/CAPACITY



[a] First quarter

HOW MADE

Shaft mining of ore containing mostly chloride salt followed by purification of potassium chloride; solution mining of potassium salts, largely chloride, followed by purification

MAJOR END USES

Fertilizer 95%

FOREIGN TRADE

Exports—700,000 tons in 1980, imports—6.6 million tons in 1980, primarily from Canada

PRICES

$90 to $120 per ton, depending on grade and type

COMMERCIAL VALUE

$200 million for total production, 1979; $280 million, 1980

U.S. potash producers will be able to sell all they can mine this year as was the case in 1979. Potash production, however, will be just a third of U.S. demand, the rest of which will be met by imports, mostly from Canada.

U.S. potash production is expected to be almost 2.4 million tons measured as K_2O in 1980, up slightly from 1979 production of 2.3 million tons. To do this, producers will have to run their nameplate capacity of about 2.9 million tons of K_2O as high as it can go—something they also did in 1979.

Total use of potash in the U.S. in 1980 could top 7 million tons. More than 95% will be in fertilizer. The remainder, about 300,000 tons, will go to industrial uses, mainly manufacture of potassium chemicals for a variety of uses, including specialty glass, detergents, and drugs.

Foreign trade in potash is much higher relative to production or use than is trade in most other large-volume chemicals. Imports this year will total about 5.6 million tons measured as K_2O. Canada likely will account for all but 200,000 to 300,000 tons of the imports. Exports will come to about 700,000 tons or about 30% of U.S. production.

Geography accounts for much of this unusual import-export situation. When finally processed after initial mining, potash from just about all U.S. and Canadian sources meets standard specifications. This allows a lot of optimizing in shipping.

The result is that the U.S. has large exports to South America because economics favor these over Canadian material in some sales. By contrast, imports from Canada to U.S. consumers in upper-Midwest farming regions have lower freight costs than does U.S. potash brought from the Southwest.

For some years to come, Canada will remain the major supplier of potash to the U.S. In fact, Canada is expected to increase exports to the U.S. to handle most U.S. demand growth.

U.S. production may increase but not without problems. Ore quality in the principal potash-producing area in New Mexico is declining slowly in percentage of K_2O. This means that more raw material must be processed each year at higher energy costs just to sustain output.

About one eighth of U.S. potash capacity is based on solar evaporation to concentrate salts. Production from this capacity depends on the weather and so changes radically from year to year. However, it is not large enough to have a big impact on total U.S. production.

As might be expected for a product consumed almost entirely in a single end use, potash has developed several main grades. In practice, the name potash includes several potassium salts. The vast majority, about 95%, is potassium chloride, known in the trade as standard muriate of potash. The rest is potassium sulfate and a dual salt of potassium and magnesium sulfates. The sulfates are preferred for some crops such as tobacco and citrus because of the danger of "burning" with the chloride.

In granular fertilizer, potassium chloride is physically mixed with nitrogenous and phosphatic fertilizer materials. This use takes about 55% of muriate of potash. In fluid fertilizer, either solutions of up to 11% K_2O or suspensions of potassium chloride at higher concentrations are added to fluid forms of other fertilizer ingredients.

Industry sources expect that farmers will use all the potash available in the U.S. in 1980 in spite of some uncertainty about grain production. The likelihood of surplus potash this year seems remote. In fact, more potash might be used if it were available, since new research on crop production shows the value of added potash.

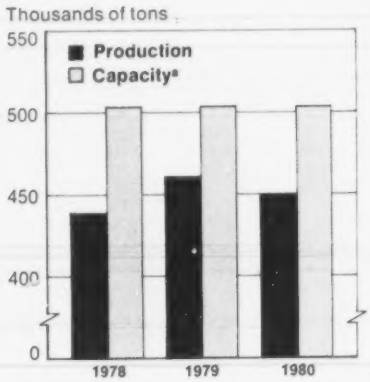
However, transportation limitations at seasonal peaks in demand hold down market growth. Storage capacity closer to the user continues to grow, but the current high cost of maintaining inventories works against greater product buildup before peak periods. One innovation being tried to alleviate the transportation problem is the use of unit trains to ship potash from Canada to the Midwest. The first of these, from CP Rail, went into operation in January with a goal of 250,000 tons per year.

For the potash industry in the U.S., 1980 now looks like an extension of recent trends. Growth in output will be small. No new capacity of any size will be added and existing capacity will be used to the hilt. Prices will increase to maintain profits as producers pass along increased costs of energy, other production factors, and transportation.

Phosphorus

- ***Output off a bit***
- ***Capacity flat***
- ***Prices rising***

PRODUCTION/CAPACITY



a First quarter

HOW MADE

Electric furnace reduction of phosphate rock with carbon and sand as aids

MAJOR DERIVATIVES

Phosphoric acid and derivatives 85%, other chemicals and derivatives 10%

MAJOR END USES

Detergents 45%, foods and beverages 15%, metal treating 10%

FOREIGN TRADE

Exports—down to about 25,000 tons in 1980 after surge in 1979, imports—negligible

PRICES

55 to 65 cents per lb

COMMERCIAL VALUE

$500 million for total production, 1979; $600 million, 1980

U.S. phosphorus producers were surprised by slightly larger demand than expected last year resulting from a surge in exports. However, producers expect production in 1980 to post a small decline. Forecasts put 1980 production at about 450,000 tons, off about 10,000 tons from 1979.

No increase in plant capacity, now about 505,000 tons, is expected for 1980. Prices probably will continue rising. However, market pricing in phosphorus is not very significant, since most phosphorus is converted to derivatives at the same site.

These output, capacity, and price conditions typify a very mature product. Production of phosphorus has tended downward in recent years mainly because of curbs or bans on derivative phosphates in detergent formulations. Capacity has been flat since 1976, when an electric furnace at Tennessee Valley Authority was shut down. No new capacity has been announced or even rumored.

A lack of capacity expansion when furnaces are running at 88% of nameplate capacity doesn't worry producers. In the past, capacity use has reached more than 95% on an annual basis. That can easily be done again if electric power is available at costs permitting additional output of phosphorus and derivatives and if customers are willing to pay.

Without a single ton of additional capacity, industry sources say that production of phosphorus could reach 480,000 tons per year, probably higher. In addition, one small unit, now closed, could be restarted, and debottlenecking might be possible on most other units as well.

Expansions in phosphorus demand could be coming in several smaller-volume uses such as sulfide, oxide, and chloride compounds. However, these uses together take only about 50,000 to 55,000 tons of phosphorus per year. If these uses grow at an optimistic rate of 5% per year—spurred by growing outlets such as flame-retardant additives for polymers, wear-extending additives for lubricating oil, and pesticides—their total effect on phosphorus demand still will be small.

By far the largest single use of phosphorus is still sodium, calcium, and potassium phosphates used in detergents as "builders" to minimize redeposition of dirt and to add other properties. These three phosphates account for more than one third of U.S. demand for phosphorus.

The decline in use of detergent phosphates since the mid-1960's led to the long decline in production of elemental phosphorus after the peak of 623,000 tons in 1969. However, few, if any, new curbs are due for detergent phosphates in specific U.S. regions. As a result, a slow renewed growth has begun for phosphate builders, roughly equal to population growth in U.S. market regions outside areas with curbs or bans. Sales of new powder detergent formulations with high phosphate concentrations are increasing fast, probably at the expense of liquid detergents, which could now have slower growth. The liquids were widely used as replacements for powders when phosphates came under the legislative gun.

For the longer term, the whole detergent picture is muddled. For 1980 specifically, current trends could bring a 1 to 2% increase in phosphorus use in detergent phosphate.

A distant second-largest use for phosphorus, about 15% of total demand, is in high-purity phosphoric acid and derivatives, called food grade, used in many prepared foods, beverages, and dentifrices. Again, many of these products have reached maturity with their slow growth tied to gross national product.

Crucial to most uses of phosphorus and derivatives is their cost compared to cost of potential substitutes such as detergent silicates. And crucial to phosphorus's own cost is the cost of energy, especially electric energy needed to run the furnaces that make it. Currently, energy costs are rising rapidly. Energy supply has some clouds over it, too, especially hydroelectric power at western U.S. phosphorus sites when rain and snowfall are abnormally low as in recent quarters.

It is certain that energy costs will increase the cost of phosphorus and its derivatives in 1980 and beyond. This will be a major factor extending phosphorus's defensive market posture of the past decade.